UNCLASSIFIED

Defense Technical Information Center Compilation Part Notice

ADP022569

TITLE: Reservoir Cathodes - Recent Development

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: 2006 IEEE International Vacuum Electronics Conference held jointly with 2006 IEEE International Vacuum Electron Sources Held in Monterey, California on April 25-27, 2006

To order the complete compilation report, use: ADA453924

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:
ADP022420 thru ADP022696

UNCLASSIFIED

Reservoir Cathodes – Recent Development

Bernard Vancil
e beam, inc.
21070 SW Tile Flat Road, Beaverton, OR 97007
email: bernie@ebeaminc.com

Edwin G. Wintucky
NASA Glenn Research Center
21000 Brookpark Road, Cleveland, OH 44135

Introduction

We review recent work on reservoir cathodes both by our organization and by others. Reservoir cathodes differ from impregnated cathodes in that barium emissive materials are stored in a reservoir attached to, but separate from, the cathode matrix. A diagram of our miniature reservoir cathode is shown in Figure 1.

Keywords: thermionic cathodes; reservoir cathodes; dispenser cathodes

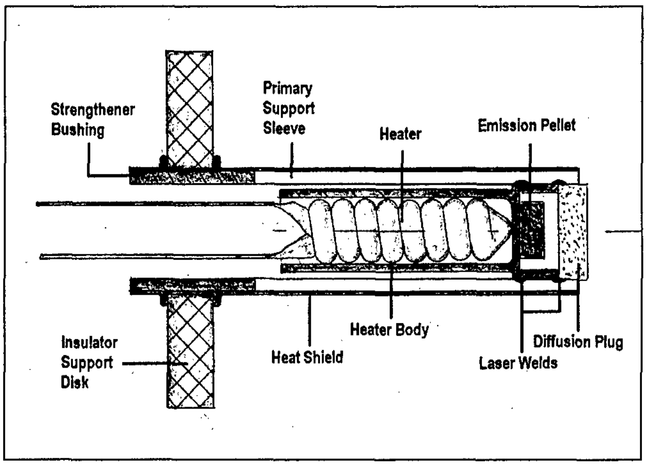

Figure 1. Miniature Reservoir Cathode

A cathode's longevity is, to a large extent, determined by how long it is able to supply barium to its emission surface. The reservoir is capable of providing much larger amounts of barium to the cathode surface over a longer time than impregnated or other kinds of cathodes. Moreover, there is little constriction of the matrix pores over the life of the cathode due to reaction by-product buildup. This is a serious life-limiting mechanism on impregnated cathodes. Consequently, reservoirs meter barium at uniform rates, whereas impregnated cathodes exhibit diminished rates of barium evolution to the cathode surface.

We will review recent work on:

1. an improved diffuser plug, the sintered wire approach, by Calabazas Creek Research, Inc.
2. reservoir hollow cathodes for ion engines.
3. our miniature reservoir cathodes.

Sintered Wire Diffuser Plugs

A project is currently underway at Calabazas Creek Research, Inc. to bundle fine tungsten wires, hydrostatically press them, and sinter. The resulting channelized matrix is infiltrated with methacrylate and sliced into sections for use as diffuser plugs. Wires and channels are normal to the cathode emission surface. Pore size, pore uniformity, porosity (% of solid density) and pore interconnectivity are critical factors in a reservoir cathode's ability to deliver the correct amount of barium to the emission surface. The most critical and least controllable of these is pore interconnectivity. In pressed powder cathodes, this interconnectivity is difficult to achieve without resorting to excessively large pore/powder sizes or under-sintering. Large pore/powder size means poor barium coverage and excessive barium evaporation. Under-sintering weakens the matrix. But sintered wire cathodes have a pore interconnectivity of close to 100%, even when small wires are employed. This is a significant improvement. Also, strength is much higher. Consequently, the matrix can be thinner without fracturing, which means more conduction of barium for a given channel size through the matrix. We will report progress to date.

Reservoir Hollow Cathodes

NASA has pursued a new generation of high-power ion engines with extended lifetime demands (>100k hours). The discharge current required is higher for high power systems, typically leading to higher insert (emitter) temperatures and shortened life with traditional impregnated inserts. NASA-JPL has developed a reservoir-type hollow cathode because, despite its complexity, it is the only technology capable of sustaining a near-constant rate of barium delivery to the emitting surface over the required extended lifetime. Test cathodes have been built and a number of designs and materials evaluated. Figure 2 is a schematic of a typical reservoir hollow cathode such as might be used in a high power ion propulsion system, such as those planned for use on the Jupiter Icy Moons Orbiter (JIMO) mission, which has since been cancelled. The gas supply is delivered from the left, ionized in the cathode interior, and electrons, used to excite ionization in the main discharge chamber of the engine, are extracted from the interior plasma via the orifice on the right. We will report results to date.

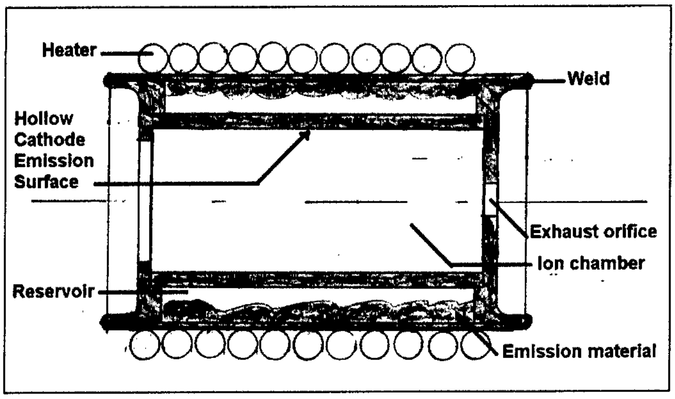

Figure 2. Hollow Reservoir Cathode

Miniature Reservoir Cathodes

E beam, incorporated continues to develop a line of miniature reservoir cathodes ranging from .050 inches in diameter to .125 inches. We will discuss life test data and the results of studies to characterize barium and barium oxide concentrations at the surface of the cathode. Cathode activation times vary widely and we have determined that variations in surface concentrations of barium and barium oxide are the cause of this variation from cathode to cathode. Our chief tool in making this determination is a mass spectrometer placed close to the cathode surface, which measures barium and barium oxide desorption as a function of time and temperature. We will discuss efforts to improve uniformity of diffuser plugs and emission materials to overcome this problem.